SPECIFICATION

To All Whom It May Concern:

Be it known that I, E. Seth Harbuck, a citizen of the United States and a resident of the State of Louisiana, whose post office address is 104 Carrollton Avenue, Shreveport, LA 71105, have invented new and useful improvements in a

LOW COST FUEL PUMP AND FILTER ASSEMBLY

EXPRESS MAIL NO: EV 255300040US

CROSS REFERENCE TO RELATED APPLICATIONS NOT IN BACKGROUND OF INVENTION.

This application is related to United States Provisional Patent Application No. 60/412,892 filed September 23, 2002 from which priority is claimed.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

Not Applicable.

BACKGROUND OF THE INVENTION

This invention relates to a fuel pump and filter assembly found, and in a fuel delivery system for, small internal combustion engines, in particular, two stroke and four stroke engines.

Among a variety of factors driving the development of small internal combustion engines by manufacturers, are consumer demands for more powerful and more environmentally friendly engines, as well as regulations pertaining to the use and operation of these engines. Conjoined with these factors is a need to build a product that is cost-effective in reducing emissions and supplying power.

One solution to these problems is fuel injection. Fuel injection for small internal combustion engines has many potential advantages, among them being reduced fuel emissions. However, fuel injection typically increases costs. In order to provide fuel injection to small engines, in particular two and four cycle engines, components must be reduced in size and simplified in order to be considered practical for implementation in the engine design.

The United States Patent to Hajj, et al. No. 6,343,596 ('596) describes a fuel injection system for small engines, which provides a microprocessor-based system for operating a fuel regulatory valve. The specification of the '596 patent is incorporated herein by reference as if fully stated. While the fuel pump of the present invention is intended to operate in conjunction with a system similar to the system described in the '596 Patent, the present invention also provides an improved fuel regulator over that described in the '596 specification. The present invention is microprocessor controlled and is intended to operate at frequencies of between 30-50 hertz. The small size of the fuel pump is an important consideration in the engine type for which the invention of the '596 patent and the present fuel pump finds application.

BRIEF SUMMARY OF THE INVENTION

One of the objects of this invention is to provide a low cost fuel pump.

Another object of this invention is to provide a fuel pump that is adaptable to the operation of two and four cycle internal combustion engines.

Another object of this invention is to provide a fuel pump construction that permits an excitation coil to be easily mounted on the pump body.

Yet another object of this invention is to provide a combination fuel pump and filter assembly.

In accordance with this invention, generally stated, a miniaturized fuel pump is provided in which a two-piece body houses a plunger. The plunger is reciprocated in the body by an intermittently excited coil energized by an

independent microprocessor that derives the signal for energizing the fuel pump from various engine parameters. The body of the fuel pump is intended to permit direct winding of the excitation coil on the body. In the alternative, the excitation coil may be free-wound and later placed on the body in proper relationship to the plunger.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

In the drawings, Figure 1 is a sectional view of one embodiment of the present invention.

Figure 2 is an end view of one embodiment of the present invention.

Corresponding reference characters indicate corresponding parts throughout the several views of the drawings.

DETAILED DESCRIPTION OF THE INVENTION

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Figure 1 shows one illustrative embodiment of a fuel pump A of the present invention. The major components of the fuel pump A are an enclosure 100, a piston assembly 34, a coil assembly 21, and a check valve assembly 22. The enclosure 100 comprises a housing 1, a first housing end cap 2, and a second housing end cap 3. The piston assembly 34 comprises a piston end cap 7, a machine ball 17, and a piston 8 acting together as an inertial check valve. A reset spring 10 and a check valve 22 are include to further coordinate the piston assembly. In this embodiment, the first housing end cap 2 and the second

housing end cap 3 are made from Delrin®, and the housing 1 is made from metal. It will be appreciated, however, that the housings made be made from other materials such as nylon or Teflon®, or the housings may be made from any rigid material provided the materials selected are capable of withstanding the pressures within the fuel pump A and will not deteriorate in the presence of petroleum based fuels. The housing 1, the first housing end cap 2, and the second housing end cap 3 are joined together by any suitable means. Conventional fasteners work well for example. Other fastening methods will be apparent to those skilled in the art.

A filter cap 40 is attached to the first housing end 2 by means of matching threads on the filter cap and the first end housing. A filter 43 is located between the filter cap 40 and the first housing end cap 2 and is held in position by a filter spring 41 located between the filter 43 and the filter cap 40 as the spring 41 presses against a filter end plate 42. An O ring 44 is used between the filter cap 40 and the first end housing 2 to seal the interior of the filter cavity. A threaded opening 45 allows fuel connectors (not shown) to be attached to the filter cap 40.

The first housing end cap 1 is generally cylindrically shaped and includes an annular offset 26 to allow for connection to the housing 1. An annular ridge 27 on the first housing end cap 2 acts as a shoulder to locate the housing 1 onto the first housing end cap 2. A threaded portion 23 on the first housing end cap 2 allows for installation of the fuel pump A onto various types of mounting configurations. A bore 29 and a counter bore 30 provide a channel for fuel flow through the fuel pump A, and the counter bore 30 also acts to help locate and

install the piston end cap 7 and the machine ball 17. A pipe thread 24 is located on the axial centerline of the first housing end cap 2 allows for the installation of various fittings which allow fuel lines (not shown) to be attached to the fuel pump A.

The second housing end cap 3 also includes an annular offset 28 to located the housing 1 onto the second housing end cap 3. A wiring raceway 20 is bored into the second housing end cap 3 to allow a set of conductors 19 of a coil assembly 21 to exit the fuel pump A. In the present embodiment, the set of conductors 19 is connected to a microprocessor (not shown) that provides the intermittent electrical impulses that cycle the fuel pump A and thereby oscillate the piston 8 within the fuel pump A to pump fuel. A second bore 32 and a second counter bore 33 in the second housing end cap 3 allow for fuel flow through the fuel pump A and for the installation of the check valve assembly 22 and the reset spring 10. As with the first housing end cap 2, a pipe thread 25 is located on the axial centerline of the second housing end cap 3 allows for the installation of various fittings which allow fuel lines (not shown) to be attached to the fuel pump A. It understood that when the components of the fuel pump A are assembled, there is an axial opening extending through the fuel pump A.

The coil assembly 21 is positioned between the first housing end cap 2 and the second housing end cap 3. A wire spool 4 of the coil assembly 21 is located within the fuel pump A by a first spacer 5 and a second spacer 6. Each of the spacers 5 and 6 are washers that have axially located openings to allow for the flow of fuel through the fuel pump A. A tube 9 is positioned in axially

alignment with the bore 29 of the first housing end cap 2 and the second bore 32 of the second housing end cap 3, the tube 9 acting as a guide for the piston 8 as it oscillates within the fuel pump A in reaction to the intermittent energizing of the coil assembly 21 by the microprocessor.

In the present embodiment the wire spool 4 is constructed from suitable plastic material. While the present embodiment shows the wire spool 4 constructed in one piece, in other alternative embodiments, the wire spool 4 may be constructed in two parts, with one portion of the wire spool 4 being hat-shaped and the second portion being washer-shaped. In such embodiments, the coil assembly 21 would be assembled by placing a free wound coil onto the hat-shaped portion, the washer-shaped portion thereafter being attached to the hat-shaped portion to create the wire spool 4. In the alternative, the electrical winding may be wound directly onto the wire spool 4.

In the exemplary embodiment shown herein, the fuel pump A is operated using electrical impulse of between about 8 and about 14.5 volts direct current, with a preferred voltage of about 12 volt direct current, and at an RMS current of about 1,000 mA maximum. It will be appreciated that other voltages may be used in other embodiments of the invention. For example six volts direct current can be used when the electrical windings of the coils are manufactured for that voltage. While operating at an oscillating frequency of between about 30 Hz and about 50 Hz, the embodiment shown functions at about a 50% duty cycle. The described embodiment delivers a mass flow rate of about 20 pounds of fuel per hour at a pressure of between about 5 psig and about 15 psig. The present

invention operates in an ambient temperature range of between about 0° C and about 60° C.

The piston end cap 7 is held in place within the counter bore 30 of the first housing end cap 2 by an O ring 18. The machine ball 17 is positioned between the piston end cap 7 and is generally held in position by the piston 8 as the piston 8 is biased against the piston end cap 7 by the reset spring 10.

In operation, when the coil assembly 21 of the fuel pump A is not energized, the reset spring 10 biases the piston 8 against the machine ball 17 and the piston end cap 7. The biased piston 8 presses against the machine ball 17 to seal the machine ball 17 against the piston end cap 7. It is understood that when the fuel pump A is installed into a fuel line of an internal combustion engine, the axial opening through the components of the assembled fuel pump A are filled with fuel.

When the microprocessor energizes the coil assembly 21 by sending an electrical impulse into the set of conductors 19, a solenoid effect is generated that biases the piston 8 away from the piston end cap 7 and toward the check valve assembly 22. The movement of the piston 8 forces fuel through the check valve assembly 22 and through a fuel connector (not shown) that is installed into the pipe threads 25 of the second housing end cap 3. The fuel then continues into the fuel system of the internal combustion engine, eventually entering the cylinders of the engine.

When the microprocessor stops sending an electrical impulse to energized the coil assembly 21, the coil assembly 21 is de-energized and allows the reset

spring 10 to return the piston 8 into its rest position by biasing the piston 8 against the machine ball 17 and the piston end cap 7. As the piston 8 returns to its rest position, the check valve assembly 22 closes to prevent fuel from being pulled back into the fuel pump A by the vacuum created when the piston 8 is biased by the reset spring 10.

It is understood that the coil assembly 21, which operates the piston 8, is activated in a predetermined manner by a microprocessor. Operation of the microprocessor is disclosed in the above referenced U.S. Patent No. 6,343,596, incorporated by reference, and is not described in detail herein.

Numerous variations within the context of the appended claims will be apparent to those skilled in the art. Merely by way of example, and not by limitation, the design silhouette of the enclosure 100 and the first housing end cap 2, the second housing end cap 3, and the housing 1 may vary in other embodiments of the invention. It is noted that these variations are merely illustrative.

While the above description describes various embodiments of the present invention, it will be clear that the present invention may be otherwise easily adapted to fit any configuration where a low cost, microprocessor-controlled fuel pump may be utilized. In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained. As various changes could be made in the above constructions without departing from the scope of the invention, it is intended that all matter contained

in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.